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A. H. VanLandingham

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AGRICULTURAL EXPERIMENT STATION
WEST VIRGINIA UNIVERSITY

WILLIAM R. FORTNEY
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COLORFUL MOUNTAINEERS

ON THE COVER:
(Dove Creel photos)

GERANIUMS are one of the most popular flowering plants and are used to add color in window boxes, various containers, and in garden beds. One of the principal restrictions to even wider garden use of geraniums has been the relatively high cost of individual plants. Most plants are produced from rooted cuttings (costing 16½ cents each) and sold in four-inch clay pots at a wholesale cost of 45 to 60 cents each. However, practically all bedding plants grown for flowers are reproduced from seed (costing less than one cent each) and sold in market units of a dozen plants.

The creation of true breeding geraniums makes possible seed production of this popular plant. The three seed-produced varieties to be introduced by the Department of Horticulture are as follows: Mountaineer White, Mountaineer Snowstorm, and Mountaineer Pink. All three varieties are free-branching and flower profusely under graden conditions.

Mountaineer Pink

(Springfield Violet x Pink Cloud) x Snowball

Dominant arrangement on the cover

Mountaineer Pink is a free-flowering dwarf variety which is true breeding from seed. Although developed as a bedding type, its free-branching, compact growth habit lends it to pot culture.

The inflorescence is a bright rose color, with the base of the petals white. There are 40 to 52 florets. The leaves of this variety are dark green, with little zonation, and have lightly toothed margins.

Mountaineer White

(Mme. Buchner x Pink Cloud) x Mme. Buchner

Right inset on the cover

Mountaineer White is a free-flowering, bedding-type geranium which breeds true from seed. It has a vigorous, self-branching growth and develops rapidly into a sturdy plant with unusually attractive foliage. The leaves are distinctively ruffled, lustrous, and dark green, with readily visible dark green zonation. The pubescent leaves are ruffled and round, with margins that are slightly lobed and toothed.

The dense clusters of 48-50 flowers are borne on a stalk that is uniquely curved, thus giving the entire arrangement a soft, more informal appearance. Floral parts are arranged in groups of five.

Mountaineer Snowstorm

(Pink Cloud x Mme. Buchner)

Left inset on the cover

Mountaineer Snowstorm is a free-flowering, white variety which is true breeding from seed. This variety is self-branching and performs best under garden conditions. The chalk-white inflorescences are compact and contain 42 to 85 florets with bright orange stamens.

The foliage is dark green, although individual leaves are lightly zoned. The leaves are round, pubescent, with toothed margins.

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APRIL 1966

GOOD PASTURE LAND CAN ADD MORE DOLLARS!

A. H. VanLandingham, *Director*

AT PRESENT, there are over three million acres of pasture land in West Virginia. The value of such land is an important part of the $48,538,000 which was realized in 1963 from the sale of grazing animals and their products. This figure represents half of the State's agricultural income for that year.

Much of the State's pasture land is in poor condition. With improvements there is every reason to believe that the sale of products dependent upon good pasture can be doubled. To realize this goal, brush control is essential, and soil fertility must be improved. Studies indicate that brush can be controlled economically by the use of herbicides, and that grazing land can be improved with lime and fertilizer.

Bluegrass, in combination with white clover, forms the basis of productive native pastures when soil fertility, management, and climate are in good balance. However, these pastures do not withstand heat and drought, especially when the white clover content is low, and therefore there is a limited capacity during the summer. This limitation is still greater when fertility levels are low.

High temperatures and drought affect most native pasture species. Growth is restricted to spring and early fall, except in high elevations and high rainfall areas.

There is need for pasture plants that can supplement or counteract the deficiencies of bluegrass. It seems possible that certain grasses and legumes might complement bluegrass and white clover during hot dry months so as to raise carrying capacity of pasture more in line with the needs of the grazing animals.

The possibility of improving grazing practices through management, and supplementing bluegrass and white clover with orchardgrass or tall fescue, will be investigated in a new pasture at the Reedsville Experimental Farm in Preston County. Through this study, it is hoped that a way can be found to enable State farmers to realize a greater yield from their pastures, contributing more to the farm economy.

UNDERPLANTING:

A Method of Replacing Unproductive Hardwood Stands With Yellow-Poplar

Kenneth L. Carvell
Silviculturist

SOME of the best hardwood lands in West Virginia support stands of no present or future value. Natural replacement of unproductive stands by trees of better species or form requires many decades unless man intervenes.

Unmerchantable hardwoods gain control of a site in various ways. Many low-value stands have resulted from destructive logging operations in which all salable trees were cut repeatedly, leaving only undesirable species or defective trees to dominate the site. Many others have originated on abandoned pastures when an adequate desirable seed source was not present. Under these conditions bird-disseminated species of low commercial value eventually become established, giving way only after a half century or more to the more valuable cove hardwoods, oak-hickory, or northern hardwood mixtures.

Hardwood planting presents many problems. Because of the consistent failures when attempting to establish hardwood plantations, major emphasis in forest tree planting has been on conifers. Hardwood seedlings do not survive as well as conifers where a thick grass sod is present. On these sites, seedlings are engulfed and smothered by the faster-growing grasses, or become stunted or die because they cannot compete for soil moisture with the dense network of fibrous grass roots. In addition, hardwood seedlings are often destroyed by rodents[1] or cut back by rabbits. During the seedling-stage many species of hardwoods benefit from partial shade. Shading reduces the density of the grass sod, and thereby increases the amount of available soil moisture. Shade also decreases evaporation from the soil surface.

To determine an effective method of replacing low-value stands with more productive hardwoods, a series of underplantings was established between 1954 and 1960 at the University Farm Woods in Monongalia County. The purposes of these plant-

[1]See *Mice—Two Species Work to Destroy Hardwood Seedlings; Poison Stops Them* by K. L. Carvell and E. H. Tryon. *Science Serves Your Farm and Home*, February 1961. W. Va. Univ. Agr. Expt. Sta. Bull. 452. pp. 7-8.

Figure 1. An old field which has seeded-in with hawthorn and crab apple. Where such cover occurs on lower slopes, yellow-poplar underplantings can be used.

TABLE 1

Per Cent Survival and Number of Permanently Deformed Trees on the Underplanted Plots Five Years After Plantation Establishment.

Plot Number	Herbicide Treatment	Number of Seedlings Planted Per Acre	Number of Live Seedlings Five Years Later	Per Cent Survival	Number of Deformed Seedlings*	Per Cent Deformed
1	Cupping	1,048	800	76.3	24	3.0
2	Basal Spray	1,168	1,012	86.6	52	5.1
3	Basal Spray	792	504	63.6	28	5.6
4	Basal Spray and Frills	1,248	801	64.2	24	3.0
5	Frills	1,076	636	59.1	40	6.3

*The number of living seedlings which had permanent stem deformities from breakage or crushing by falling tops, limbs or trees, five years after underplanting.

ings were to determine if yellow-poplar (*Liriodendron tulipifera* L.) can survive and grow beneath a deadened overstory; the best method of removing the overstory; and the extent of damage to the underplanted seedling as the overstory trees die and fall.

Experimental Area

The area selected for this study was former pasture land, abandoned during the 1930's. The test plots were located on lower slopes where moisture conditions favorable for yellow-poplar prevail. The nearly-complete cover consisted of typical bird-disseminated species: crab apple (*Malus coronaria* [L.] Mill.), hawthorn (*Crataegus* spp.), sassafras (*Sassafras albidum* [Nutt.] Nees), sumac (*Rhus* spp.), and blackgum (*Nyssa sylvatica* Marsh). Most of these species do not have commercial value and won't have in the foreseeable future. The height of the overstory trees varied from 25 to 50 feet. Grasses and scattered herbs occurred in the understory. Their abundance varied with available soil moisture and amount of overhead shade.

Previous work in this typical old-field type has indicated that if the overstory is cut and the site planted with conifers or hardwoods, a dense thicket of sassafras, crab apple, and hawthorn sprouts and root suckers springs up, forming an impenetrable barrier to the planted seedlings.

Plantation Establishment

In the five test underplantings, which varied from a quarter to a half acre in area, a spacing of 6 by 6 feet was originally planned. During planting it was found that the location of the trees presently occupying the site made it difficult to follow a rigid spacing pattern. Thus, the position of the seedlings was somewhat irregular, placing each in the most favorable location for survival.

In three of these plots 1-year-old, or less, yellow-poplar stock was used, and in the others 4-year-old seedlings were planted. Past experience has shown that the older seedlings have an advantage over the smaller 1-year-old stock where there is lush herbaceous vegetation.[2]

In early April, just prior to planting, the overstory hardwoods were treated with Ammate in cups, or frilled or basal sprayed with 2, 4, 5-T.[3] On one plot, trees smaller than 3½ inches d.b.h. were basal sprayed and the larger trees were frilled. Although the plantings were made just one week after herbicide application, there was no apparent damage to the yellow-poplar from herbicide persisting in the area.

Collection of Data

Five years after these underplantings, each plot was examined to determine per cent survival and the number of seedlings that had been crushed or permanently deformed by falling limbs and boles. The results of these counts are presented in Table 1.

Discussion

On all plots a sufficient number of yellow-poplar survived to provide a suitable stand without permanent deformities. However, seriously damaged or dead seedling often occurred in groups, leaving areas of poor stocking. Although none of these patches was large enough to reduce the value of the plantation significantly, the trees surrounding these

[2]See *Combat Herbaceous Competition with the Use of Large Yellow-Poplar Planting Stock* by K. L. Carvell, *Science Serves Your Farm and Home*, January 1966. W. Va. Univ. Agr. Expt. Sta. Bull. 520, pp. 3, 4, 16.

[3]For more information on herbicide application see *The Use of Herbicides in Forest Management Practices in West Virginia* by K. L. Carvell and H. P. Berthy. W. Va. Univ. Agr. Expt. Sta. Circ. 115.

Figure 2. A yellow-poplar stand 10 years after underplanting. Although a complete overstory existed at the time of planting, little damage occurred to the developing yellow-poplar as the overstory disintegrated and fell.

Figure 3. Underplanted seedlings are usually damaged in groups where vines have tied overstory trees together, or where dead overstory trees have fallen before their crowns have disintegrated.

Figure 4. If overstory trees deteriorate slowly while standing erect, the twigs drop quickly, later the branches come down, and finally the denuded boles fall. Gradual disintegration of the standing trees causes less serious damage to the understory seedlings.

Figure 5. It is desirable to revisit underplanted plots at the beginning of the second growing season to re-treat trees that failed to respond to the first herbicide application. The large dying trees in this picture were not re-treated until 5 years after the plantation was established. When they fall, considerable damage to the yellow-poplar will result, since poplar becomes less limber and less resilient with age.

(Continued on Page 19)

Figure 2

Figure 3

Figure 4

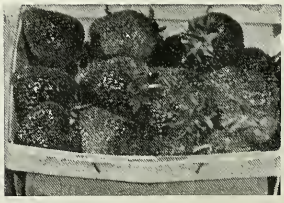
Figure 5

Marketing West Virginia Strawberries in Out-of-State Markets

The beautiful mountains of central and southern West Virginia are rich in natural resources and aesthetic value. However, they provide difficult problems for agriculture. In these mountainous areas one finds many small, isolated, and widely separated parcels of cultivatable land unsuited for efficient use of modern farm machinery. Thus, it is difficult for farmers in these areas to be competitive in the production of crops adaptable to mechanization. Farm income in these areas is quite low in comparison to other parts of the State and the United States. In many instances, agricultural resources are not fully or efficiently employed, and capital investment per farm is small.

The problem of low farm incomes, surplus labor, and underemployed agricultural resources can be partly eliminated by producing intensive crops that require large amounts of labor, small amounts of machinery and which return a relatively high profit per acre. Strawberries appear to fulfill these requirements, providing markets are available for selling the berries.

R. L. Jack
Asst. Agricultural Economist



PROCEDURE

A study was made to determine the location and characteristics of markets available for strawberries produced in West Virginia. Personal interviews were conducted with 109 buyers for wholesalers, commission merchants, and food chain firms. The 109 firms were located in 11 cities in 10 states.

For purposes of analysis, the 11 cities were divided into three markets: the Northern market—comprised of buyers in Pittsburgh, Cleveland, and Buffalo; the Eastern market—Baltimore, Washington, Richmond, Raleigh, and Columbia; the Southwestern market—Cincinnati, Louisville, and Nashville.

FINDINGS

Interest

The 109 buyers interviewed were asked: "If we were to have 50,000 to 100,000 crates of strawberries in West Virginia during the May 15-June 30 period would you be interested in handling some of them?" Buyers in the Northern market were the most interested. Seventy-eight per cent of them gave a definite "yes" answer to the question, while in the Southwestern and Eastern markets only 54 and 55 per cent of the buyers respectively gave a "yes" answer.

Method of Selling

The buyers definitely interested in buying our strawberries also recommended methods of selling that should be used. Almost all commission merchants recommended that producers consign strawberries to commission merchants for selling. Buyers for food chains preferred to purchase directly from the producers. Other types of wholesalers (distributors, receivers, receiver-jobbers, etc.) were split about evenly between recommending consignment and direct purchase methods of selling.

Size and Quality Desired

Buyers in the three markets were asked which one of the following size-quality options they would prefer to handle:

Option 1—U.S. No. 1 or combination containing fruits of various sizes but many small fruits which can be retailed at 39 cents per quart or 3 quarts for one dollar;

Option 2—U.S. No. 1 uniformly large and excellent quality which can be retailed for 45 to 49 cents per quart.

More than 55 per cent of the buyers in the Southwestern and Northern markets preferred to handle the uniform, large, quality strawberries offered in Option 2. Only 30 per cent of the buyers in the Eastern market preferred Option 2, and 41 per cent said they would prefer handling equal amounts of both options. It is interesting to note that no buyers in either of the three markets selected only Option 1.

Food chains in the Southwestern and Northern markets were more inclined toward the large, high quality strawberries than chains in the Eastern market. In all three markets the majority of the commission merchants indicated that they preferred strawberries other than the uniform, large, excellent quality berries (Option 2). At least 50 per cent of other wholesalers in all three markets preferred to handle the high quality berries (Option 2). A larger proportion of food chains and other wholesalers selected the best quality strawberries (Option 2) than did commission merchants.

The difference between the high percentage of buyers in the Southwestern and Northern markets and the low percentage of buyers in the Eastern market who preferred the high quality strawberries may be explained partially by the high proportion of commission merchants in the Eastern market.

Shipping Under Refrigeration

More than 40 per cent of the buyers in all three markets indicated that it was compulsory that strawberries be shipped to them under refrigeration. Twelve per cent or more of buyers in all markets said refrigeration was needed sometimes. Twenty-eight per cent or more of the buyers in the three markets indicated that strawberries should never be shipped under refrigeration.

In all markets the highest proportion of food chains and other wholesalers require that strawberries be shipped under refrigeration while the highest proportion of commission merchants in the three markets do not want refrigerated shipments.

Different refrigeration requirements by the three types of buyers are probably the result of the various marketing functions performed by each buyer. Food chains normally have facilities to keep the berries under refrigeration until sold to consumers. Commission merchants normally do not maintain refrigeration facilities. Therefore, if strawberries are shipped under refrigeration and not kept under refrigeration by the buyer, quality can deteriorate rapidly.

Type of Package Preferred

Quart containers were preferred for strawberries by more than 45 per cent of the buyers in all three markets. Pint containers were the second most popular in all markets.

Except in the Northern market, more food chains preferred pints than quart containers. In all markets, commission merchants strongly preferred quart over pint containers. Container preference by other wholesalers varied with the market considered.

Desired Time of Delivery

The organizational structure of a buying firm influences the time of day that delivery of goods is desired. That is, firms employing only one shift of workers may want delivery of goods between 8 a.m. and 5 p.m. Firms having more than one shift of employees may want night delivery to facilitate storing, packaging, and displaying the product for the next day's business.

More than half of the buyers in all three markets wanted strawberries delivered between midnight and 6 a.m.

In selling to other wholesalers or commission merchants, harvesting activities in West Virginia should be organized in such a way as to permit strawberries to arrive at these firms between midnight and 6 a.m. Possibly the berries could be picked in the morning and placed in coolers at assembly points to be loaded and shipped by 6 p.m. This time schedule would permit the strawberries to arrive at the buying firms in all three markets between midnight and 6 a.m. This arrangement would permit most of the strawberries to be in the consumers' possession within 24 hours after harvest. A different delivery schedule is needed when selling to food chains.

Primary Source of Supply

The perishable nature of strawberries makes it necessary to hold the time interval between harvest and consumption to a minimum. Where markets are located great distances from the point of production,

(Continued on Page 22)

PICK THE EASY WAY

W. H. Childs, N. C. Hardin, C. E. Hickman, and C. B. Sperow, Jr.*

Above, 12 pickers harvest strawberries from the picker transport at the Ohio Valley Substation. Machine was designed and built by the Department of Agricultural Engineering. Right, is a close-up view of the pickers as they work from the transport.

BECAUSE of the relatively small amount of land in West Virginia suitable for intensive cultivation, it is important that a high percentage of this land be used for crops which can give high per-acre cash income. Strawberries, one of the few such crops that can be grown as well in this State as elsewhere, return a high net income. Therefore, the West Virginia Cooperative Extension Service, the State Department of Agriculture, and the Farmers' Home Administration are cooperating in promoting increased strawberry production in the State. In order for their efforts to be successful, it is necessary that all cultural operations which can decrease the amount of hand labor required, increase the quality of the fruit sent to market, and minimize the hazards inherent in growing this crop be studied.

A project for work on strawberry problems was initiated in 1963 at the Ohio Valley Substation and on the Horticulture Farm and in the Horticulture Greenhouse at Morgantown. This project is being expanded in 1966 to include research by several departments. Some of the most urgent problems needing study are:

(1) *What herbicides will give best weed control, and how and when should they be applied?* (2) *Can other mulching materials be substituted satisfactorily for the too-expensive wheat straw presently recommended?* (3) *Is soil fumigation practical in West Virginia for control of strawberry pests?* (4) *Is the use of a picker transport feasible under West Virginia conditions?* (5) *What varieties are most satisfactory for growing in the State and marketing through the Farmers' Markets?* (6) *Is it economical to irrigate for frost protection and increased yields under West Virginia conditions?* (7) *What row width and plant spacing will give maximum yields and highest quality fruit, and how can row width and plant numbers be most efficiently regulated?*

Two growing seasons do not provide sufficient time to obtain answers to many of these questions, but considerable information, some of which is listed below, has been gathered in certain areas.

Varieties—In a comparison of four varieties suitable for marketing through wholesale channels, Midway and Surecrop were distinctly superior to Dixieland and Tennessee Beauty in yields and berry appearance. Midway out-yielded Surecrop by about 37 per cent—9,702 vs. 7,008 quarts per acre—but susceptibility of Midway to verticillium wilt and herbicide injury may make it preferable for some farmers to grow Surecrop. Surecrop also has greater resistance to red stele root rot, although Midway has some resistance to this disease.

Herbicides and fumigation—Fumigation was compared with cultivation and with the Eptam-Simazine herbicide combination† recommended for West Virginia for three varieties. Fumigation showed no advantage over cultivation in yields, but both the fumigated plots and cultivated plots out-yielded the herbicide plots by about 30 per cent. The summer of 1963 was very dry, which favored the cultivated plots and was unfavorable to the herbicide plots, and results must be considered with this in mind. Fumigation was somewhat disappointing in that it controlled weeds for only 60 days. In order to justify the expense, longer control of weeds would be

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†For details, see Current Report 40, April 1964, W.V.U. Agr. Exp. Station.

Solids-Not-Fat

Samuel J. Weese
Associate Dairy Scientist

SOLIDS-not-fat was a term not fully understood until recently. Today it is becoming a part of dairy farm language. Formerly, the emphasis was on butterfat, but today the trend is toward more emphasis on the other constituents of milk, such as protein, lactose, and minerals.

Several states have developed systems and are incorporating protein and solids-not-fat (SNF) into their regular testing program. Washington and Oregon have developed plans to incorporate protein and SNF testing into units. Just recently a West Virginia Dairy Herd Improvement Association tester was asked by six of his producers to include testing for SNF.

If the DHIA tester is to assume responsibility for an additional test, it must be a relatively simple test, one of low cost, reasonably accurate, and not too time-consuming. These factors will rule out protein testing for the present until a suitable test can be developed.

The two SNF tests used in the field are the Watson lactometer test and the plastic hydrometer beads test, usually referred to as the Golding Bead Test.

SNF testing was started with the West Virginia University dairy herd in 1962. Since that date, SNF data on each cow in the milking herd have been collected monthly by the use of the Watson lactometer method. These data are being recorded on data processing cards. One set is sent to the director of the Northeast Regional research project; the second set is retained by the West Virginia University Agricultural Experiment Station in order to study the factors that affect the solids-not-fat.

The Golding Bead Test is preferred by DHIA testers and other field workers in testing individual cows for solids-not-fat.

At the West Virginia University Experiment Station, a comparison was made on 317 samples from individual cows of the University herd using the Watson Lactometer test and the Golding Bead Test. The results were comparable. The bead test average for SNF on the 317 samples was 8.99 per cent and the Watson test was 8.94.

In testing for SNF by use of the bead test, it is necessary to utilize colored plastic beads. Each bead has a different density, which makes it float or sink in the milk, depending on composition of the milk.

When ready to test, the milk is warmed to 104 degrees Fahrenheit in a water bottle and held for five minutes. Each sample is thoroughly mixed so that all fat is evenly distributed in the milk. The milk samples are then placed in a container to temper the samples to exactly 68° F. While the temperature is dropping from 100°-90° F., the tester pipetts a sample for the Babcock test in the usual manner. When the milk reaches 68° F., the samples are gently remixed and placed on a mirror. The test is read by counting the number of plastic beads on the bottom of the jars. A handy conversion chart enables the tester to read the SNF directly.

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necessary, unless nematode control were a very important factor. More fumigation studies are planned for the future.

Between the time plants are set in the field and the period, five or six weeks later, when the Eptam-Simazine herbicidal combination can be safely applied, weeds may become very injurious to the planting. Greenhouse studies indicated that plants whose roots had been dipped in activated carbon could tolerate herbicides immediately. Field trials gave inconclusive results, however, and further trials are necessary before recommendations can be made. Soil type was found to be an important factor influencing the effectiveness of the herbicides and the amount of injury sustained by the strawberry plants.

In a study of different methods of applying the herbicides Eptam and Simazine, it was found that applying the materials separately as a spray was somewhat superior in weed control to other methods, but the granular mixture used by most growers in West Virginia was commercially satisfactory. Those growers with sprayers available might find it worthwhile to apply the materials separately in a liquid form.

Mulching—Mulching studies to date have been indicative only. Sudan grass, millet, three combinations of these materials, chopped corn stalks, and oat straw were compared with wheat straw. None of the materials was quite so good as wheat straw, but sudan grass showed enough promise to warrant further studies.

Picker transport—A picker transport carrying 12 pickers was designed and built by the Department of Agricultural Engineering and tried at the Ohio Valley Substation in 1964. Some mechanical weaknesses need correction, but certain promising features were seen. Picking was less tiring to pickers when using the transport and more berries per picker could be harvested in a half day than by conventional methods. The berries and pickers were both shaded, and the sooner berries are protected from the sun the firmer they remain. It also is possible to use lights on the transport and pick at night when picking conditions are more nearly ideal. One disadvantage of the transport is that field grading of the berries is impractical.

Additional herbicide studies, row width and plant spacing experiments, fertilizer studies, irrigation investigations, and further work with the picker transport are planned.

METHODS OF FROST PROTECTION

W. H. Dickerson
Agricultural Engineer

Damage to crops from freezing has been recognized for centuries throughout the world, and various protective measures have been developed. The history of frost protection goes back at least as far as 77 A.D., according to F. D. Young, when Pliny the Elder issued advice on this subject in his *Natural History*. In more modern times, many European countries have used heat and smoke for protection, and California citrus growers were using fires to prevent frost damage as early as 1897.

Practical experience by farmers and growers, as well as fairly extensive controlled experiments, have established the basis for a number of methods of protecting against late spring or early fall freezes. The protective measures in common use are sometimes classified as: *passive,* including location of growing areas, choice of growing season, selection and breeding of plants, and cultural practices; *active* methods which include covering, artificial fogs, wind machines, sprinkling or flooding, heating, and forced harvest.

Single wind machine in an apple orchard in the Eastern Panhandle, near Martinsburg.

Irrigation equipment for frost protection, cooling, and supplemental irrigation of strawberries, Ohio Valley Substation.

METEOROLOGICAL ASPECTS

The terms frost and freeze are sometimes the subject of some confusion. Two types of frost are generally recognized: white frost, composed of ice crystals, and black frost, in which no ice is formed but plant tissues are injured and blackened by freezing. A freeze is a numerical substitute for the term frost and means the occurrence of a temperature of 32° F or lower, as measured in a standard shelter with the thermometer about 5½ feet above the ground. The following discussion is all in the context of the latter definition.

Frost occurrence may be divided into two categories: the intrusion of air masses with below freezing temperatures throughout the air mass, which will be called advective freezes; and development of inversions causing below freezing temperatures at the earth's surface through radiative cooling. This situation is called a radiation frost.

The advective freeze, or "frost with wind" is similar to a cold wave. A large mass of cold air moves over an area and the cold may last several days. Protective measures such as sprinkler irrigation or heaters are usually ineffective because of strong winds, massive chilling, prolonged low temperatures, or a combination of these factors. The frequency of advective freezes limits efforts to protect against frost, because this severe hazard can only be eliminated, if at all, by the most drastic and expensive methods.

Inversions occur when the normal temperature - elevation relationship of a decrease in temperature with an increase in altitude is reversed. Four types of ground inversions are sometimes distinguished: radiative, air drainage, advective, and frontal.

The radiation frost, common in late spring and early autumn, is associated with radiative inversions and cold air drainage. Weather conditions usually include a slow-moving high pressure area with cool dry air. Daytime temperatures may be well above freezing, but rapid cooling by radiation during nights with light or calm winds and clear skies, often causes surface temperatures to fall below freezing. Air in contact with the radiating ground surface is cooled by conduction. A shallow layer of cold air is formed which gradually deepens. The cold air has a tendency to flow downslope and collect in low places. It is not unusual for differences of 10 to 15 degrees Fahrenheit to develop in a height of 50 feet, with the colder air near the ground.

FROST PROTECTION METHODS

A discussion of all of the protection measures mentioned above will not be attempted. Instead, three aspects of frost protection which seem to have particular relevance to West Virginia will be examined. In the categories described, one method is passive, i.e., the use of frost probability levels for choice of growing season or for choice of site, and the other two are active methods, which involve physical control of temperature by sprinkler irrigation or wind machines.

Frost Probability

The probabilities for spring and fall low temperature dates were determined for the Northeastern United States, including West Virginia, by the NE-35 Technical Com-

Two wind machines are used in this apple orchard in the Eastern Panhandle. (Second machine, barely visible in the background, is indicated by the arrow.) Two or more machines will protect more acres per machine than a single unit, such as that shown on the opposite page.

mittee. The results were reported by A. H. Havens and J. K. McGuire.[1] Twenty-three weather stations were included for West Virginia, providing fair areal coverage for the State. Havens and McGuire presented, by means of tables, the date when the risk of frost reached certain probability levels. The development of these data, through the analysis of longtime weather records by digital computer, made available for the first time a simple method for estimating the risk of freezing temperatures on any given date in the spring and fall.

Within the constraints of the statistical theory and meteorological considerations involved, the data can be used to select the growing season for crops where an alternative exists for planting or harvesting dates or for the selection of growing areas. The constraints or limitations may be outlined as follows:

If probability analysis of historical weather data shows a 25 per cent chance that frost (temperature $\leq$ 32° F) will occur after a certain date (or conversely that there is a 75 per cent chance that frost will be over by this date), the meaning is that on the average over a long period of time, 3 years out of 4 can be expected to have no frost after the specified date. However, the derivation of the frequency relationship offers no clue as to which individual years will be frost free after the date in question and which ones will not.

Also, from the discussion of radiation frosts it can be inferred that frost occurrence is often spotty. In the hilly terrain of West Virginia, the probabilities of frost at a weather station may not be the same as for a farm or orchard only a short distance away.

[1] *The Climate of the Northeast—Spring and Fall Low Temperature Probabilities*, N. J. Agr. Expt. Sta. Bull. 801. 1961.

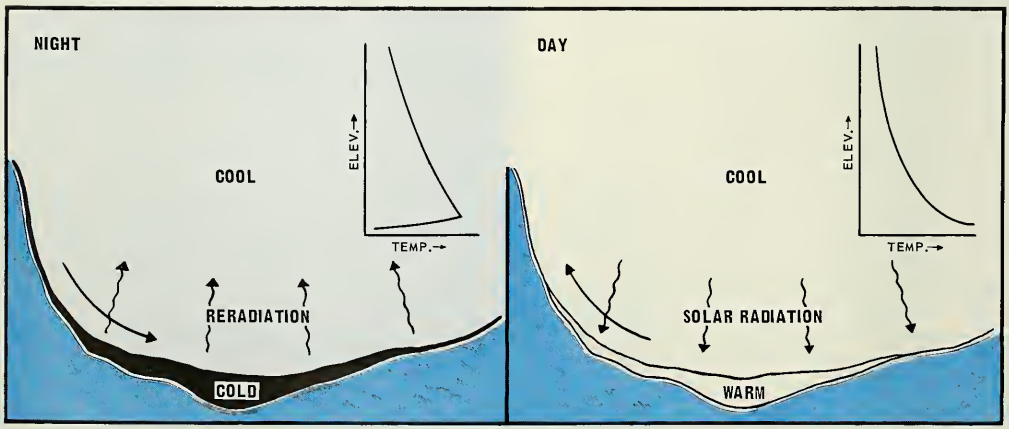
Protection by Sprinkling

Protection against frost damage can be secured within certain limits by sprinkling crops with water throughout the time that the freezing temperature lasts. The water will freeze and cover the plant with a coating of ice. When water freezes, heat (144 btu/lb) is released and this tends to keep the temperature of the plant high enough to prevent damage. If the irrigation water is above freezing, heat (1 btu/lb/°F) is available from the cooling of the water to 32° F. The freezing process is by far the most important source of heat. An ice coating tends to shield the plant against freezing air temperatures but protection is afforded only while the ice is kept wet. It is essential that water be applied until the air temperature goes above 32° F and all of the ice is melted from the plant. If not available from other sources, heat may be drawn from the plant during the melting process, resulting in frost damage.

This method of protection has proved successful with many low-growing crops such as tomatoes, cucumbers, peppers, and beans, and is of particular interest in West Virginia for use with strawberries. The successful use of sprinkler protection for tree crops has also been reported. Generally, sprinkling can protect crops when temperatures are as low as 8 to 10 degrees below freezing.

A solid system irrigation layout is used in sprinkling for frost protection because water must be applied simultaneously to the entire area to be protected. A sprinker discharge capacity to achieve an application rate of about 0.10 to 0.15 inch per hour with a sprinkler rotation of about one revolution per minute has generally been successful. The success of the system is related to the correct rate and uniformity of application, the speed of sprinkler rotation, and adjustment of equipment and methods to compensate for the adverse influence of increased wind speed. The effect of an increase in wind speed can be overcome up to a point by a higher rate of application and by closer spacing.

For most cases where sprinkler irrigation is needed for frost protection, the possibility of using the equipment for cooling and for supplemental irrigation for soil moisture control should be considered.



DAY: On sunny days, solar and sky radiation reaching the earth are changed to heat and warm the surface. The earth's surface, in turn, heats the air. Air near the ground may become much warmer than the air above.

NIGHT: The earth loses a maximum amount of heat to space by back-radiation on clear nights, with a dry atmosphere. On calm nights, the surface quickly becomes colder than the air above. Denser cold air tends to move downslope by gravity. It is in this type of situation that a wind machine may be able to prevent frost damage by drawing down warm air and mixing it with the colder air near the surface. Outgoing radiation cools the surface regardless of topography, but valleys with poor drainage of cold air are usually the most frost-prone sites.

Protection by Wind Machines

The use of wind machines for frost protection has met with favor in some areas, notably for citrus orchards in California and Florida. The principle of drawing down warmer air from above and mixing it with colder air near the ground to effect a temperature rise is limited to the situation presented by an inversion.

Usually, a temperature rise of no more than 3° or 4° F can be obtained from a wind machine. The acreage protected by a single machine will vary depending on the strength of the inversion, the topography, and wind drift. Reports seem to indicate that a machine of 80 to 90 bhp can provide a 2° F temperature rise (somewhat higher closer to the fan) over 10 to 15 acres under the most favorable conditions.

The works of F. A. Brooks offer a good insight to the application of wind machines for frost protection. His investigations in California apply mostly to citrus orchards. Summarizing highlights of investigations that seem to have significance for orchards in the State: wind machines offer protection against freezing only when inversions exist; with light inversions or wind drift, fans with heaters may be more effective; the turning machine with the jet of air directed a few degrees below the horizontal has been found to be an effective arrangement; and two or more machines will protect more acres per machine than one machine alone. Professor Brooks observed that wind machines have not proved as effective in deciduous orchards as in citrus, probably because of friction created by the interlocking branches in the tops of deciduous trees.

SUMMARY

Three ideas for frost protection have been discussed: the passive method, and the active methods of sprinkler protection and the use of wind machines. The passive method, dependent on selection of growing area, seems to offer a practical approach. Sprinkler protection has been established as a useful method most promising for low-growing crops. However, the potential for tree crops, such as peaches or apples, should not be overlooked. Frost protection by wind machine is being tried on a limited scale in the orchards of the Eastern Panhandle. Further study is needed on the performance of these machines.

The Changing Nature of The State's Egg Industry

John C. Tharne and James L. Stallings*

*At the time of this study, John Thorne was a Graduate Research Assistant. He is now an Economist with the USDA. James L. Stallings is Assistant Agricultural Economist.

THE NUMBER of laying hens on West Virginia farms has declined sharply in recent years. In 1954 the average number of layers on West Virginia farms was 2,260,000 but by 1964 this figure had dropped to 1,540,000—a decline of nearly 32 per cent. At the same time, the number of layers in the United States decreased by only slightly over 5 per cent. During the period 1954 through 1964, egg production in West Virginia decreased by 18 per cent, but egg production in the United States increased by 9 per cent.

At a passing glance, egg production in West Virginia might appear unprofitable. However, things are not always what they seem. Much of the reduction, for example, has been in the large number of relatively inefficient farm flocks, while the more efficient commercial flocks have remained about the same. When some of the factors affecting the State egg industry are analyzed, it would appear that West Virginia egg producers enjoy some advantages over other sections of the United States.

STRONG POINTS

Egg Prices

Probably the most outstanding advantage which State egg producers have over producers in other areas is the high farm price of eggs. During the period 1960-1964, West Virginia producers received an average of 5.6 cents per dozen more than the United States average. Projections of past trends indicate that this differential will continue through 1969 (Figure 1).

Egg-Feed Price Ratio

The egg-feed price ratio is the number of pounds of feed which is equal in value to one dozen of eggs at the farm level. Because feed is the largest single expense involved in the production of eggs, making up nearly two-thirds of the total cost, the egg-feed price ratio is an indicator of the profitability of producing eggs. The egg-feed price ratio in West Virginia has averaged nearly .8 of a point or nearly 10 per cent

(Continued on Page 23)

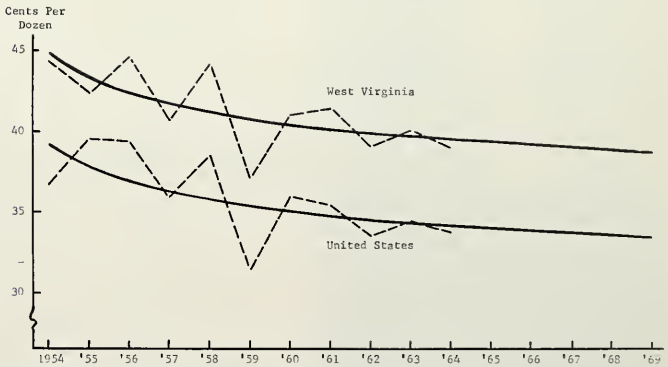


Figure 1. Farm price of eggs, W. Va. and U. S., 1954-1964, with trends and projections, 1954-1969.

TODAY, a farmer must produce efficiently and economically to meet competition. Farming units have been increasing in size to increase production. However, on many farms the expansion of dairy or beef herds has not been accompanied by equal changes in acreage or intensity of feed crop production and utilization, with the result that farmers are forced to depend to a greater degree on purchased grain and hay for the nutrient requirements of their animals. Yet TDN (total digestible nutrients) in home-grown grain and forage can be produced at half, or less, the cost of TDN in purchased grain.

According to estimated production cost figures, TDN can be produced for about $2.00 per 100 pounds as either hay, corn grain, or corn silage where farming practices support relatively high yield levels (90 bushels corn, 16 tons corn silage, or 3.5 tons good hay per acre). Purchased TDN in a typical formula feed costs about $5.40 per 100 pounds at present prices.

Although the cost of producing a pound of TDN from corn silage or hay does not differ greatly, corn silage is in many respects the more economical source of nutrients for cows. Corn silage produces almost twice the nutrients per acre as other feed crops. In 1962, according to the *Annual Crop Summary* published by the United States Department of Agriculture, farms in the Northeastern states produced 10,916,000 tons of silage from 984,000 acres of corn, compared to 10,865,000 tons of hay produced from 7,528,000 acres. The hay acres planted to alfalfa and alfalfa mixtures were, however, more productive than these figures might indicate, producing 6,130,000 tons on 2,256,000 acres. In terms of total TDN production per acre, a 16-ton yield of corn will provide approximately 7,000 pounds of TDN while a 3.5-ton yield of good hay will provide only about 4,300 pounds of TDN. These figures are low for high level or optimum production on good land. Under optimum conditions corn will easily produce 25-30 tons of silage, while alfalfa will make 5-6 tons of hay or 17-20 tons of haylage. Using a TDN figure of 65 per cent for both forages the corn would produce approximately 10,000-12,000 pounds of TDN per acre, while the alfalfa would produce only 6,800-8,000 pounds of TDN.

CAN SAVE YOU DOLLARS!

MELVIN W. JOHNSON*

*Melvin W. Johnson, formerly Associate Agronomist, is now Associate Professor of Agronomy at The Pennsylvania State University.

TABLE 1

Corn Silage Evaluation Study—1960-62.

Hybrid	Yield (T/A)	Dry Matter (Per Cent)	Total Dry Matter (T/A)	Crude Protein (Per Cent)	TDN (Per Cent)	TDN/A (Pounds)
1960						
W. Va. B-25 ...	17.3	34.6	6.0	8.7	72.9	8,719.2
W. Va. 7802 ...	21.5	33.1	7.1	7.8	64.6	9,202.0
N. J. 8	22.0	34.2	7.5	6.9	61.7	9,284.0
N. J. 9	23.9	35.1	8.4	7.1	66.6	11,185.2
1961						
W. Va. B-25 ...	17.9	34.4	6.2	8.4	71.9	8,842.6
W. Va. 7802	19.7	31.1	6.1	7.3	64.1	7,819.6
N. J. 8	20.4	30.7	6.3	7.4	62.7	7,833.6
N. J. 9	22.0	34.0	7.5	7.1	65.4	9,768.0
1962						
W. Va. B-25 ...	16.3	29.4	4.8	9.4	69.9	6,683.0
W. Va. 7802 ...	19.6	29.6	5.8	9.2	66.2	7,659.6
N. J. 8	19.8	28.0	5.5	8.8	67.0	7,405.2
N. J. 9	22.8	24.3	5.5	9.2	65.5	7,237.7
3-year averages						
W. Va. B-25 ...	17.2	32.8	5.7	8.8	70.8	8,242.5
W. Va. 7802 ...	20.3	31.3	6.4	8.1	65.0	8,234.1
N. J. 8	20.7	31.0	6.4	7.7	63.8	8,174.2
N. J. 9	22.9	31.1	7.1	7.8	65.8	9,397.0

In 1960 a study was undertaken to evaluate certain corn hybrids for both quality and quantity of silage produced (Table 1). Four hybrids, representing four maturity groups, were selected for testing. In order of maturity from the earlier to the later maturity they were W. Va. B-25, W. Va. 7802, N. J. 8, and N. J. 9 (600, 700, 800, and 900 maturities, respectively). These hybrids were planted in quarter-acre, duplicated plots each at a rate of approximately 20,000 plants per acre in late spring (around June 1) after the first cutting of either alfalfa-orchard grass or wheat-vetch had been removed for silage. Each year 700 pounds of 13-13-13 or equivalent was plowed down just before planting and 150 pounds of 10-10-10 was applied in the row at planting. A pre-emergence spray application of 2.5 pounds per acre of atrazine (80W) was applied each year for weed control. The plots were not cultivated. A similar type of study was conducted in 1964 with several commercially available hybrids (Table 2).

The plots were harvested in the fall at the hard dough or glazed stage with the leaves still green, yields were measured, and samples of the forage ensilaged for analysis. After the forage was properly fermented, duplicate samples of each were analysed. Pertinent information obtained on a dry matter and actual basis was: dry matter, crude protein, digestible protein, predicted digestible energy, and total digestible nutrients (TDN).

Results for the initial three-year study are given in Table 1. Significant differences among lines are apparent for most factors. N. J. 9 was significantly better than the others in yielding ability on a fresh and dry weight basis as well as on a total TDN basis. W. Va. B-25, although significantly lower in total fresh and dry matter yield, was not significantly lower than N. J. 8 and W. Va. 7802 in TDN produced per acre. Being earlier and somewhat shorter in growth habit it has a better ration of ear to stalk weight, thus accounting

TABLE 2

Corn Silage Evaluation Study—1964.

Hybrid	Yield (T/A)	Dry Matter (Per Cent)	Total Dry Matter (T/A)	Crude Protein (Per Cent)	TDN (Per Cent)	TDN/A (Pounds)
N.J. 8	22.3	36.0	8.0	8.2	65.3	10,448.0
N.J. 9	24.3	32.8	8.0	10.1	66.3	10,541.7
Todd 892	25.5	29.9	7.6	8.3	66.4	10,119.4
DeKalb 805	20.6	36.8	7.6	7.5	61.6	9,350.9
W. Va. 7802	22.5	33.0	7.4	9.5	66.3	9,852.2
Pioneer 3284	22.7	31.8	7.2	9.5	74.2	10,714.5
N.J. 10	23.8	30.0	7.1	9.0	66.1	9,425.9
Pioneer 321	23.0	30.3	7.0	10.4	66.0	9,200.4
Southern States 909E	23.5	29.5	6.9	8.7	64.1	8,884.3
Todd 880	20.6	32.1	6.6	9.1	62.3	8,236.1
Todd 862	21.1	31.0	6.6	8.3	67.5	8,842.5
DeKalb 640	24.4	26.6	6.5	9.6	64.2	8,346.0
W. Va. B-25	18.8	34.2	6.4	9.2	63.9	8,192.0
Funk G-96	19.0	33.0	6.3	10.2	68.7	8,656.2
W. Va. 773	20.8	29.9	6.2	9.9	67.6	8,382.4
Funk G-114	18.8	33.0	6.2	9.9	65.9	8,158.4
Funk G-77	19.1	29.9	5.7	11.3	65.1	7,421.4
Funk G-44	17.9	27.1	4.9	9.6	71.1	6,896.7

for its equivalent TDN yield per acre, since ears and grain have a much higher level of digestible nutrients than do the stalks. Dry matter digestibility is 55-65 per cent for fodder, 83-88 per cent for whole ears with husks, and about 95 per cent for grain. Thus the higher the percentage of grain produced per plant the higher the amount of dry matter and TDN that will be produced.

As shown by the results of the evaluation of several commercial hybrids (Table 2), there was a significant amount of variation among hybrids in per cent of dry matter, protein and cellulose, and thus in total digestible nutrients, produced per acre. Thus, these data, as well as that of other investigators, show that qualitative differences do exist among different hybrids. These differences can be minimized when a hybrid that is well adapted to a particular area is used. Well-adapted high grain yielding hybrids will produce superior yields of high quality forage when managed properly.

When choosing a good silage corn it is well to consider such factors as its ability to yield grain, length of growing season, total dry matter production, disease and insect resistance, and standability. It is very important that a hybrid be grown that will attain the hard dough stage (65-70 per cent whole plant moisture) during the growing season. An extremely late maturing hybrid will be carrying excess moisture at harvest, resulting in a loss of dry matter and TDN per acre. In turn the total dollar return per acre will be lowered.

It is important to keep in mind that a good hybrid, alone, will not necessarily give higher yield. One must also use adequate fertilizer and population levels along with weed and insect control and other good cultural practices. If these practices are followed and one has favorable weather conditions it should be possible to produce at least 20 tons of 65-70 per cent moisture silage per acre. In some cases, yields of 25 or more tons per acre may be attained. This was shown in our 1964 trials (Table 2) as well as in trials at other experiment stations. Therefore, from an economic standpoint, corn silage can save you dollars in feed costs in comparison with other forage and grain crops, when well-adapted high yielding hydrids are grown and good management practices are followed.

SHOULD BARROWS AND GILTS BE FED THE SAME?

D. J. Horvath and J. L. McBee, Jr.
Associate Animal Husbandmen

Gilts produce leaner, meatier carcasses than barrows of the same weight fed the same rations. This has been known for a long time, but the recent increase in demand for lean rather than fat pork has made it more important.

Recent experiments at the West Virginia University Agricultural Experiment Station suggest that gilts might profitably use more protein in their diet than barrows. When offered "high," "medium," or "low" protein levels, both barrows and gilts were leaner on the high protein diets, but the gilts responded more than the barrows.

This "interaction," as the statisticians call it, did not occur in every case. However, workers in Scotland and Florida have data suggesting the same thing.

If this happens consistently, and if processors pay adequate differential prices for leaner carcasses, it might pay larger volume feed lot operators to feed gilts separately on perhaps 2 per cent more protein than barrows.

TABLE 1

Examples of the Barrow-Gilt Differences in Carcasses at West Virginia University.

	Lean Cuts (Per Cent)	Fat Cuts (Per Cent)	Loin-Eye Area (Square Inches)	Backfat Thickness (Inches)
	1960-1961			
Barrows	49.8	39.1	3.4	1.7
Gilts	54.5	33.4	4.1	1.4
	1964-1965			
Barrows	50.6	38.0	4.0	1.5
Gilts	53.0	35.5	4.3	1.4

Some Effects of Nutrition and Environment on Growth and Sporulation of Species of *Phytophthora*

Figure 1. *Phytophthora cinnamomi. The culture at the left received no vitamin B_1; the culture on the right received* 2.5 *µg of thiamine.*

Virgil Greene Lilly
Physiologist

THE genus *Phytophthora* contains some 40 species, all of which are known to cause plant diseases. There is scarcely an economic crop anywhere in the world that is immune to attack by one or more species of this genus.

The type species of the genus (the first to be recognized and described scientifically) is the late blight fungus, *Phytophthora infestans,* a destructive pathogen on the potato and tomato. Indeed, it is a rare farmer or vegetable gardener in West Virginia who is not familiar with its ravages.

In one way or another, the plant pathologists and mycologists of the Agricultural Experiment Station have been concerned with this group of fungi since the Department of Plant Pathology was established in 1912. Much of this work has been in the laboratory where studies have been made of life cycles, morphology, nutrition, and the effects of the environment on the genus *Phytophthora.* Such studies are still going on. Indeed, more research on the genus *Phytophthora* is under way in the world at present than at any time in the past 50 years. What has been discovered in the laboratory in past years has been useful in devising disease control measures, and what is being learned now will find application in the future.

A plant pathologist can frequently identify the particular fungus causing a plant disease by the symptoms. However, it is often desirable to isolate and identify the causal organism by laboratory studies. This requires that the particular organism be separated from others present in the infected plant parts. Before a fungus can be identified it must produce spores, for these are the organs upon which a mycologist bases his judgment.

Two reasons are adduced for emphasizing the nutritional and environmental conditions required for the production of spores by species of *Phytophthora*: (1) to increase our knowledge and understanding of this genus, and (2) to furnish a sound basis for improved control measures in the future. Fungi are disseminated by spores, and epiphytotics are initiated by spores. The survival of many species of fungi depends on the formation of resistant spores. To be able to control sporulation of a plant pathogenic fungus is to control the disease caused by the fungus.

We may liken the problems facing the investigator of species of *Phytophthora* to those of St. John who beheld in a vision a roll sealed with seven seals. The first problem is to provide a medium or substrate upon which the fungus will grow. Since fungi are not photosynthetic organisms, the medium must contain all of the nutrients that the fungus requires. All fungi require much the same nutrients, including a sugar or carbohydrate, a source of nitrogen, various salts and metallic ions, and water. Some fungi require various other specific nutrients. All species of *Phytophthora* require vitamin B_1 (thiamine). The goal in studying the nutrition of a fungus is to culture it upon a medium in which all of the constituents are known (synthetic medium or medium of known composition).

In order to culture species of *Phytophthora,* the early investigators had to use media containing natural materials of unknown composition. While such media are very satisfactory for the nutrition of fungi, their use does not permit the identification of the specific nutrients required. The first seal was opened in 1937 when it was discovered by workers here and elsewhere that *Phytophthora* species required an exogenous source of thiamine for growth. This discovery, for the first time, enabled investigators to culture species of *Phytophthora* on media of known composition. It now became possible

to learn a great deal about the nutrition of these fungi, especially, the sugars and nitrogen sources utilized.

Media containing the minimal nutritional requirements proved to be satisfactory for vegetative growth. They were less satisfactory for the production of asexual spores (sporangia), and sexual spores (oospores) were seldom or never formed on simple minimal media. Evidently, the roll had other seals.

Professor L. H. Leonian, Station Mycologist from 1921 until 1945, became intensely interested in sexual reproduction by species of *Phytophthora* in the early 1930's. He found that garden peas contained something that was required for the production of oospores. Further work with this author showed that the active compound (s) in garden peas was a lipid, and that it could be concentrated following treatment with an alkali by extraction with certain organic solvents. These studies greatly limited the number of possible compounds that could be involved. Nevertheless, the active compound (s) was not recognized.

Our studies in this area ceased about 1937 and for 25 years little interest was evinced in the nature of the compound required for sexual reproduction in species of *Phytophthora*. This problem was reopened by two workers from Saskatoon in 1963, and the next year saw a goodly number of papers on this subject from this country and abroad. The substance required for sexual reproduction was identified as a sterol. Actually, a number of sterols related to cholesterol were equally active. Also it was found that the addition of a suitable sterol to a medium of known composition increased the rate of growth and the number of asexual spores produced. It is interesting to note that this discovery was made independently in at least three laboratories. We may say at this point that the second seal had been opened.

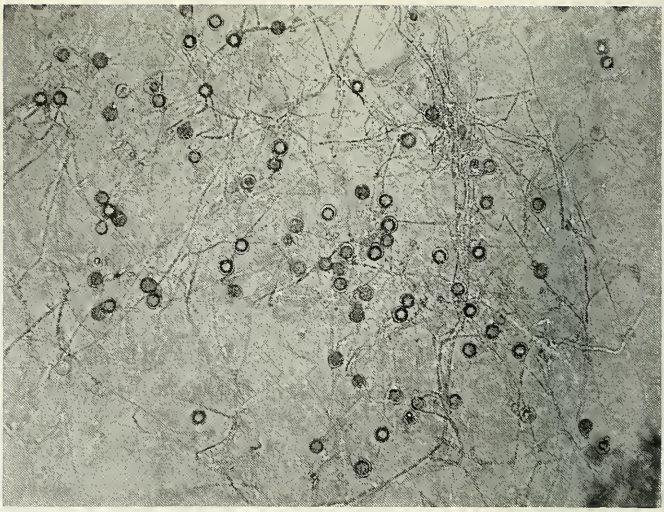


Figure 3. Oospores produced by Phytophthora cactorum in a medium containing a sterol.

While this laboratory did not discover that sterols were the compounds required for sexual reproduction by species of *Phytophthora* we have been very active in extending this discovery to many species and isolates of *Phytophthora*. In the course of this work it was found that sterols are not the sole requirement for sexual reproduction, because some species and isolates of *Phytophthora* do not form oospores when cultured on a synthetic medium containing a sterol. Evidently, the roll has still other seals.

Two species, *Phytophthora cinnamomi* and *P. cryptogea* rarely form oospores when cultured on a sterol-containing synthetic medium. Both species form oospores readily when cultured on a natural medium made from hemp seed, or when lipids from hemp seed are added to a synthetic medium. The sterols obtained from the lipid fraction of hemp seeds are largely inactive by themselves. Thus, the problem comes down to the separation of the compounds present in the crude lipid fraction from hemp seed. This seal will no doubt be opened in due time.

So far we have not mentioned the effect of environment on sporulation. It is necessary to keep the temperature of incubation somewhat lower than that optimal for vegetative growth, suitably around 20° C for the species we have studied for abundant sporulation.

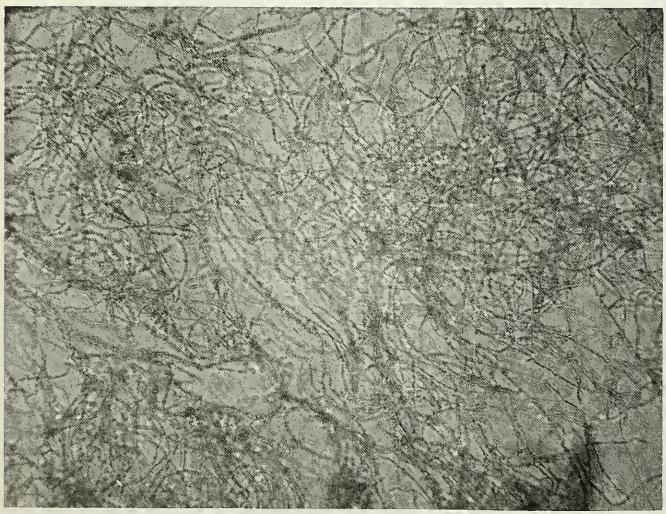


Figure 2. Vegetative mycelium of Phytophthora cactorum grown in the absence of a sterol.

Our investigations have shown that light and darkness are important variables which have to be controlled. As far as our studies have gone, most species of *Phytophthora* require some light to produce many asexual spores. The opposite is true of oospore production. Darkness is favorable for oospore production, and as little as three footcandles reduces the number formed. Thus, another seal is opened.

White light from fluorescent lamps was used in the experiments summarized above. Since the time of Newton it has been known that white light is a mixture of colored lights. The question then arose: Would different wave lengths affect sporulation of species of *Phytophthora* differently? Lacking the necessary equipment required to produce a spectrum of sufficient intensity to use in such a study, we turned to the use of filters. Our results may be summarized as follows: For sporangium formation the efficiency decreases as the wave length increases, blue light is more effective than green, and green light is more effective than red. The opposite effect was found for oospore production.

Is there any connection between the effects of light and sterols? We have shown that the inhibitory effect of light on oospore formation by two species of *Phytophthora* may be overcome by increasing the sterol content of the medium. The mechanism is not understood. Another laboratory has reported that sporangia produced on sterol-free media do not germinate, an observation that we have confirmed for one species of *Phytophthora*.

The sterols are complex alcohols which are synthesized by most plants and also by animals. Cholesterol, the common animal sterol, has been considered to be a health hazard. Many sterol derivatives are physiologically active, and include sex hormones, digitalis glycosides, toad poisons and other (steroids). Most fungi synthesize one or more sterols, primarily ergosterol. As far as is known at present, sterols are not synthesized by species of *Phytophthora;* this may also be true of species of *Pythium,* a closely related genus. It is uncertain whether *Phytophthora* species use sterols as they are obtained from the medium, or convert sterols into physiologically active compounds.

Many more seals will have to be opened before the writing on both sides of the roll may be read.

UNDERPLANTING YELLOW-POPLAR

(Continued from Page 4)

Underplanting yellow-poplar seedlings beneath a dying hardwood overstory produces vigorous, adequately-stocked plantations, and affords an effective method of replacing undersirable hardwood stands with a more promising forest type.

patches exhibited poorer pruning and form from lack of side competition and shading.

To obtain the greatest benefit to the underplanted seedlings, the overstory should die gradually over a period of two growing seasons, slowly exposing the understory to full sunlight. This affords the yellow-poplar seedlings sufficient light for vigorous growth, yet suppresses the rank growth of herbaceous plants during the first two years. Since herbicides act at different rates on each species, opening of the overhead canopy is gradual, and defoliation of all trees is not complete until the middle of the second growing season.

It is far better for the dead trees to deteriorate slowly while standing erect than to break off at a frill or girdle. If dead trees stand for several years, the twigs drop quickly, later the branches come down, and finally the denuded bole falls. Gradual disintegration of the standing tree causes less serious damage than occurs when large-crowned trees come down on top of the developing yellow-poplar understory. In this respect, basal spraying, cupping, and tree injection are superior to frilling or girdling for underplanting projects, since trees treated by the latter methods often break off prematurely at the girdle or frill.

The greatest amount of breakage occurs around the tallest overstory trees. In this experiment the overstory averaged 25 to 30 feet in height, but scattered stems rose to 40 feet or more. The year after treatment these taller trees often broke off at the frill, possibly because of the exposure of their crowns to the wind, and the complete crown fell into the plantation beneath.

Particularly heavy breakage or crushing was also observed where yellow-poplar seedlings had been planted in dense clumps of crab apple. Such thickets frequently dominated an area of 150 square feet or more. After a few of these stems had fallen, the remainder bent over, crushing everything beneath. Where crab apple thickets occur, no underplanting is justified.

On one plot only half of the overstory was treated with herbicide during the first year; the remaining trees were cupped two years later. It was originally thought that this delay would provide a more gradual removal of the overstory, thus the underplanted yellow-poplar would have more time to adjust to full sunlight and the rank growth of herbs would be suppressed. Annual comparisons of this plot with those where all of the overstory had been treated at one time did not show any appreciable advantage in delaying treatment of part of the overstory. The varying mortality rates of the different species on those plots where all of the material had been treated at once provided a sufficiently gradual release of the yellow-poplar, and no serious herb problem developed except where the site was unusually moist.

It is desirable to revisit underplanted plots at the beginning of the second growing season to re-treat trees that failed to respond to the first herbicide application. If scattered overstory trees are allowed to live until the yellow-poplar understory has reached a height of 10 feet or more, it is difficult to avoid damage to the understory when these stems are killed, since yellow-poplar stems become less limber and less resilient with age.

Extreme damage to underplanted seedlings also occurs where grape or other vines have tied many of the overstory trees together. This results in the overstory coming down, pulling over many dead trees before their crowns have disintegrated. A complete blanketing and crushing of the understory results.

Herbs cause a serious threat only on the very moist sites. Indications of a prospective herb problem are usually evident on these areas prior to removal of the overstory. Inspection of such sites the summer prior to planting would show a continuous lush herbaceous mantle. Where there are indications that an herb problem will develop after the overstory is removed, large yellow-poplar planting stock should be used, as on these sites the depth and density of the herbaceous mantle will increase after crown removal. Only 3- and 4-year-old seedlings will stand above this layer of herbs.

Utilizing By-Products of the Poultry Industry

Arthur A. Camp, Assistant Poultry Scientist

Practically every industry at one time or another has the problem of disposing of its by-products. Often this is a real problem and may be quite expensive. A few years ago the poultry industry had to spend several million dollars each year to dispose of its waste materials, but today, thanks to research and initiative, the industry reaps several million dollars annually due to either the use or sale of these materials—because all of them are being converted into high-quality ingredients for livestock and poultry feeds.

Until a few years ago, the feathers, heads, feet, and entrails from poultry processing plants were usually dumped at the nearest garbage depot or some other area approved by federal, state, city, and community health authorities. This was expensive, even if the approved area was nearby, which was not always the case. Today, most of the processors in a large integrated poultry operation have established facilities and equipment to convert offal and feathers into usable ingredients which are used in their own feed mixing operations. In some instances, other rendering plants will pick up the offal and feathers from poultry processing plants, pay for these raw products, convert them into usable ingredients and sell them to manufacturers of livestock and poultry feeds. To give one some idea about how extensive this practice is, last year more than 3½ billion pounds of waste products from poultry processing plants were converted into usable high-quality feed ingredients.

During the processing procedure the feathers and offal are kept separate because they are further processed in different cookers under different conditions at the rendering plant.

The head, feet, and entrails are placed in a large steam-jacketed cooker (these cookers will usually hold 5,000 to 30,000 pounds of raw material) equipped with a stirring device. They are cooked under approximately 30 pounds of steam pressure for about 4½ hours. The cooked material is then passed through a drier which removes most of the moisture. From the drier, the cooked and dried product is passed into a press where the oil is expelled and collected for future use in livestock and poultry feeds. The cooked, dried, and pressed material is then passed through a grinding device (usually a hammer mill), producing the finished product which is a finely ground, free-flowing material. This ingredient is sold on the feed-trade market as poultry by-products meal. This product is an excellent source of protein (usually containing from 58 to 62 per cent), energy (900 calories of productive energy), and unidentified factors known to be required for maximum growth rate for growing chickens, turkeys, and pigs. Each 100 pounds of offal processed will produce 30-35 pounds of poultry by-products meal and 8 pounds of poultry oil.

The poultry feathers are placed in a large steam-jacketed cooker equipped with a stirring device and subjected to approximately 30 pounds of steam pressure for approximately an hour. This cooked material is then dried and ground into a fine, free-flowing form, to be sold to feed manufacturers as "hydrolyzed poultry feathers." This product usually contains 85 to 92 per cent protein and is a good source of an unidentified factor necessary for maximum growth rate of growing chicks, poults, and pigs and maximum hatchability of chicken and turkey eggs.

Some processors of poultry combine poultry blood and feathers at the processing plant and cook them together as in the production of "hydrolyzed poultry feathers." This product is lower in protein content (usually 70-75 per cent) than the one obtained from the processing of poultry feathers alone but is still a good source of high-quality nutrients. In addition to this use of poultry feathers, a few, though an insignificant amount, are still used on women's hats.

One of the latest uses of poultry feathers is in the production of "foam" which is used to extinguish fires on airport landings for jet-powered planes. The impact of this use of feathers on the feed industry is yet to be determined but it is another potential market for this by-product.

Chicken, turkey, duck, and geese hatcheries have, until very recently, been plagued with disposing of egg

shells, infertile eggs, eggs containing dead embryos, etc. Research work conducted in the last five years indicates that these waste materials can be converted into a usable feed ingredient when processed properly. It is usually processed under approximately the same conditions as poultry offal and feathers. That is, the hatchery waste materials are cooked, dried, and ground into a fine particle size and sold to feed manufacturers as hatchery by-products meal. This product has been shown to contain high-quality protein (26 per cent), unidentified growth factors for chicks and pigs, a hatchability factor for poultry, and a high level of calcium (21 per cent) contributed by the egg shells. Since the supply of hatchery waste products is not always large enough to justify the establishment of facilities to process them alone, they are sometimes cooked along with offal. In either case, this one-time worthless and troublesome waste is being converted into a useful and valuable product.

Before chicks, poults, or laying hens are placed in a brooder or laying house, some type of soft and absorbent material is put on the floor. In livestock production, this is called bedding. In poultry production, it is called litter. For poultry, the litter may be sawdust, wood shavings, peanut hulls, rice hulls, ground corn cobs, pulp left from cane used in production of sugar and/or molasses, and other materials. Poultry are maintained on this litter until they are sold, at which time a portion of all of the used litter is removed from the house and new litter is put down for the next flock of chickens or turkeys. The litter removed from the house after the poultry are sold contains not only the original litter but also the droppings, some feathers, and some wasted feed. A chemical analysis of this untreated product reveals that it contains 22 to 24 per cent protein as well as significant amounts of other plant and animal nutrients. For years used poultry litter was utilized only as fertilizer and its value in improving soil fertility and productivity is well known and highly praised. This can be readily understood when one realizes that used litter contains 1½ to 2 per cent calcium, 1½ to 2 per cent phosphorus, 3 to 4 per cent nitrogen, and 2 to 3 per cent potassium (potash). However, recent research data indicate that used poultry litter can be fed successfully to all types of livestock and poultry.

Mature cattle have been fed rations containing 50 per cent used poultry litter, 35 per cent ground corn, 5 per cent alfalfa meal or ground alfalfa hay, 8 per cent molasses, 1 per cent steamed bonemeal, and 1 per cent salt over a period of eight years with outstanding success. Breeding cows fed this diet produced large vigorous calves and large quantities of milk on which the suckling calves grew well. Rations containing 25 to 35 per cent litter have produced excellent results when fed to steers and heifers under dry-lot feeding conditions. To illustrate, for example, assume that a producer raises 20,000 broilers at one time. Since they are sold at approximately nine weeks of age, at least four flocks can be raised annually, allowing time to clean after selling out and getting ready for a new flock. At this rate he will raise 80,000 broilers each year, which will produce four pounds of litter each, or 320,000 pounds of useable litter. This amount of litter would furnish 50 per cent of the feed for 175 mature cows if they were each fed 10 pounds of complete feed every day of the year. It would supply 25 per cent of feed for 350 calves fed on the same basis.

Breeding sheep and swine have utilized this waste product of the poultry industry with equal success. In many instances it has been incorporated in poultry diets at low levels (10 to 20 per cent of the total diet) and produced unbelievable results. Preliminary results of tests in progress at West Virginia University indicate that the incorporation of used litter which has been sterilized, dried, and ground at a level of 10 per cent into a commercial-type diet produced results equal to the same diet not containing the litter.

What about the potential of this as livestock and poultry feed? Last year approximately 2½ billion broilers were produced in the United States. Since each broiler produces approximately four pounds of litter, then 10 billion pounds of potential feed ingredients were produced from broilers alone. This does not include laying hens, breeding hens, turkeys, ducks, and geese which will produce more litter per bird then broilers.

There are other uses of the waste products from the poultry industry, but the main ones have been listed. No doubt additional uses will be found through further research.

Results of WVU's Ag Research Will Highlight "Field Day"

The latest research developments in agronomy and horticulture will be the topic of an Agronomy and Horticulture Field Day, Thursday, June 2, at the Ohio Valley Substation, five miles north of Pt. Pleasant.

A. H. VanLandingham, director of the WVU Experiment Station, has announced that the Field Day will begin at 10 a.m. with land judging, plant identification, and tours of the experimental research plots. The land judging and plant identification contests will be open to both youth and adults.

One of the highlights of the afternoon program will be an address by R. S. Dunbar, Jr., Dean of the College of Agriculture and Forestry, who will speak on "Resource Utilization and Production of Agricultural Crops." Tours of research plots will then be resumed until 4 p.m.

Director VanLandingham said that visitors to the Field Day will have an opportunity to view and study results of the latest station research in fertilization, weed control, tobacco production, strawberry management, insect control, corn production, legume establishment, and disease control. James W. Paterson, State Extension Specialist-Soils, will serve as field day chairman.

Staff members of the Experiment Station and the WVU Cooperative Extension Service will conduct the tours and discuss the results of years of research and development in agronomy and horticulture.

The Agronomy and Horticulture Field Day is held every two years at the Ohio Valley Station. The station can be easily reached by automobile on W. Va. Route 62.

Director VanLandingham emphasized that the Field Day is open to all. Luncheon will be served by the Mason County Home Demonstration Council at a nominal fee.

Marketing Strawberries

(Continued from Page 7)

producers attempt to maintain high-quality strawberries by field cooling, by shipping under refrigeration, and by using rapid transportation to speed delivery. Although these additional marketing services enable producers to maintain high-quality strawberries that demand higher prices, the services also increase the cost of marketing, especially if long shipping distances are involved. Since producers located near the market should be able to maintain a high-quality strawberry with fewer additional services, they should have a competitive advantage over growers situated long distances from markets.

Each buyer interviewed was asked the region of his primary source of supply during various times of the strawberry season. (The six supply regions used in the analysis are shown in Figure 1).

The primary sources from May 15-31 were the South Atlantic, Western, and South Central regions for over half of the buyers in all three markets. The South Central growers were major suppliers for the Southwestern market; the Western region was major supplier for the Northern market; and South Atlantic growers were the major suppliers for the Eastern market.

As the season progresses from May 15-31 to June 1-15 the primary supply regions for each market change. East North Central and Western regions become the primary supply for almost half of the buyers in the Southwestern market. The Western and North Atlantic regions are now the major suppliers for 68 per cent of buyers in the Northern market. In the Eastern market, the South Atlantic region is still the primary supplier for 35 per cent of the buyers, and the North Atlantic region is the major supplier for 41 per cent. From June 16-30, the East North Central and Western regions are primary suppliers for 72 per cent of the buyers in the Southwestern market. During the same period, North Atlantic and Western regions are primary suppliers for 56 per cent of the buyers in the Northern market and for 71 per cent of the buyers in the Eastern market.

By having knowledge of the highly seasonal shift of supply regions, strawberry producers can determine the market in which their crop can be most competitive.

During the early part of the strawberry season (May 15-31) West Virginia strawberries may be more competitive in the Northern than in the Southwestern or Eastern markets. During this period almost half of the buyers in the Northern market are supplied primarily with strawberries produced in the Western and South Atlantic regions, which must be shipped long distances to the Northern market. Strawberries from the South Atlantic states probably pass through West Virginia on their way to the Northern market. Considering shipping distance as a factor in competition, strawberries produced in West Virginia during May 15-31 should be competitive with those from the Western and South Atlantic regions for the Northern market.

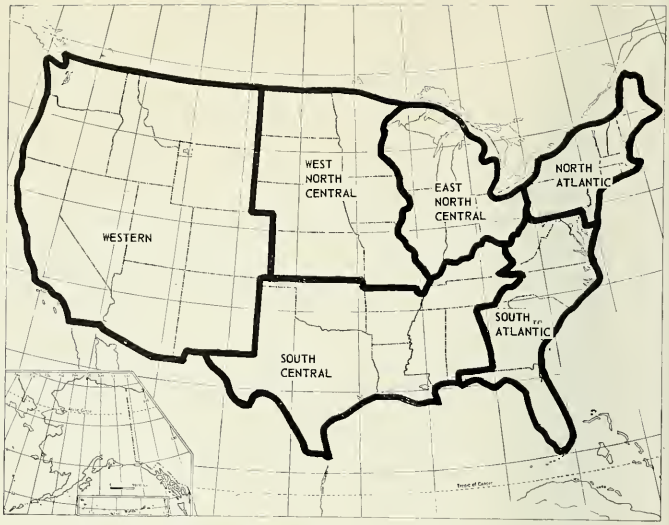


Figure 1. Primary supply regions of the United States.

Although the North Atlantic states are the major source of supply for the Northern market during June 1-15, the Western states gained as suppliers. For the period May 15-31, Western states were mentioned as major sources of supply by 28 per cent of the buyers interviewed. However, the period June 1-15 was mentioned by 32 per cent. It would appear that West Virginia berries can compete with Western berries in the Northern market during the June 1-15 period because of shorter shipping distances.

During June 16-30, West Virginia sellers could probably be more competitive in the Southwestern market where 72 per cent of the buyers said their major source of supply was the Western and East North Central states. West Virginia berries probably could compete favorably with berries from the Western states in this market.

Conclusions

Analysis of data in this study suggests that markets are available for strawberries produced in West Virginia. However, strawberry producers must make every effort to package, grade, refrigerate, and transport their strawberries according to the desires of the particular buyer—food chains, commission merchants, and other wholesalers. West Virginia strawberries should be sold in the market in which they can be most competitive. This may mean shifting to different markets during the harvesting season.

NEW PUBLICATIONS

Current Reports

45. R. O. Weedfall and W. H. Dickerson. The Climate of Bluestone Recreational Area, West Virginia. February 1966.

46. K. L. Carvell. The Effect of Stand Density on the Development of Virginia Pine in the Ohio River Area of West Virginia. March 1966.

47. L. M. Ingle. Storage Scald of Apples—Causes and Control. April 1966.

Changing Egg Industry

(Continued from Page 13)

above the United States ratio since 1954 (Figure 2). Extrapolation of trends suggest that the egg-feed price ratio will continue to decline gradually with the differential between West Virginia and the United States remaining about the same.

Consumption Exceeds Production

West Virginia is a deficit egg-producing state. State farmers account for only slightly more than half of the total number of eggs consumed in the State (Figure 3). This, in part, accounts for the higher average price per dozen received by the farmers.

Production per Layer

Although egg production per layer in West Virginia is slightly under the United States average, trends indicate that the gap is closing, and projections suggest that production per layer should approximately equal the United States average by about 1969 (Figure 4). Much of this increase is no doubt due to the decrease in the number of small farm flocks which have highly seasonal production; larger, more efficient flocks have remained and have actually increased in number. This reduction in farm flocks has contributed to a much more stable seasonal pattern of egg production (Figure 5).

Locotion

West Virginia enjoys a location advantage when compared with some other egg-producing states. Over half the nation's population lives within a few hundred miles of the State. Many of the eggs consumed in the heavily populated Northeast are produced in the Midwest. West Virginia enjoys a considerable transportation advantage over that area.

PROBLEM AREAS

Feed Cost

While the higher price of eggs, relative to the United States average, offsets the higher price of feed, the cost of feed does represent a problem for West Virginia egg producers.

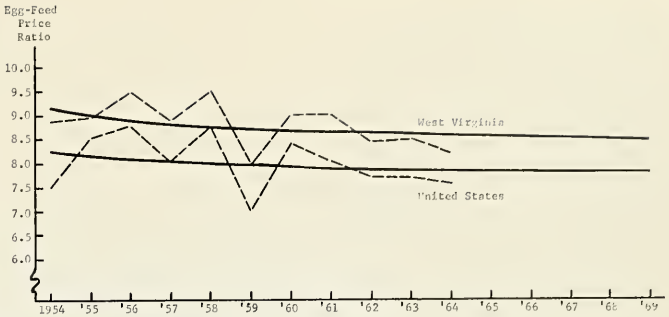


Figure 2. Egg-feed price ratio, W. Va. and U. S., 1954-1964, with trends and projections, 1954-1969.

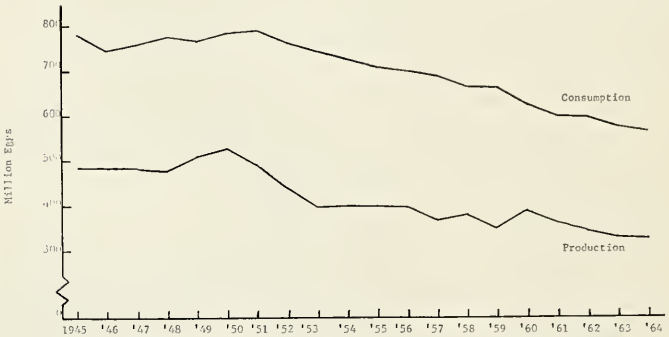


Figure 3. Production and consumption of eggs in W. Va. 1945-1964.

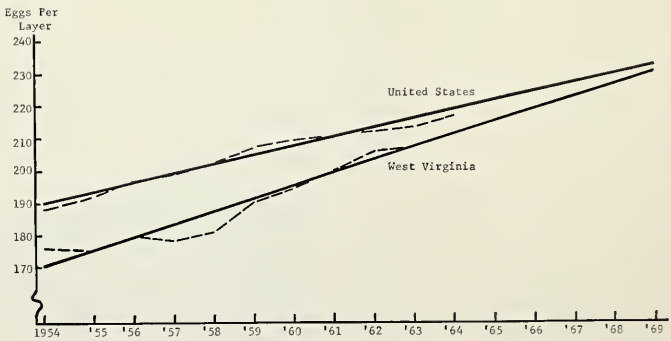


Figure 4. Eggs per layer, W. Va. and U. S., 1954-1964, with trends and projections, 1954-1969.

TABLE 1

Outlets for West Virginia Egg Producers

Types of Outlets	1944	1948	1964
	Per Cent of Eggs Sold		
Retail Stores	57	41	27
Wholesale Firms	6	25	41
Direct to Consumers	20	22	15
Other Outlets	17	12	17

Trends and projections indicate that State egg producers pay a higher price for laying mash than United States producers (Figure 6) and will continue to do so. Poultry Extension specialists are at the present time studying this problem and are carrying out a program to help egg producers realize that good feed can be obtained at a price which is competitive with other areas.

Lack of concentration of production is another difficulty. With more, and higher, concentration of production would undoubtedly come such hard-to-measure advantages as a more efficient marketing system, more competition among feed suppliers, and more, and better, dissemination of knowledge about techniques and marketing.

MARKET STRUCTURE

An egg-marketing survey conducted by the Department of Agricultural Economics at West Virginia University during the summer of 1964 revealed that, as egg production has shifted from a barnyard enterprise to a more specialized business, changes have taken place in the marketing structure.

Comparisons with two earlier studies (Table 1 and Figure 7) show that in 1944 retail stores bought 57 per cent of the eggs produced in West Virginia. In 1948 the figure was 41 per cent. By 1964 this figure had fallen to 27 per cent. In 1944, egg producers sold 6 per cent of their eggs to wholesale firms, while in 1948 wholsalers bought 25 per cent of producers' eggs. In 1964 the corresponding percentage was 41. Sales direct to consumers accounted for 20 per cent of sales in 1944, 22 per cent in 1948, and 15 per cent in 1964. Other outlets accounted for 17 per cent of total sales in 1944; 12 per cent in 1948; 17 per cent in 1964.

The shift to large-scale production operations has led to the increase in sales to wholesale firms which in many cases perform several processing functions, including washing, sizing, grading, and packaging. The decline in sales direct to consumers also reflects the trend to larger producing units.

Figure 5. Egg production in W. Va. by months of selected years.

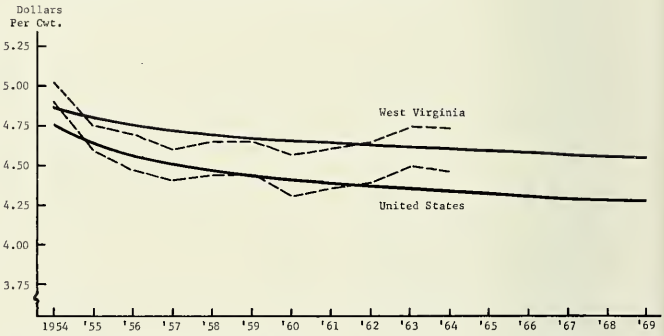


Figure 6. Laying mash price, per cwt., W. Va. and U. S., 1954-1964, *with trends and projections,* 1954-1969.

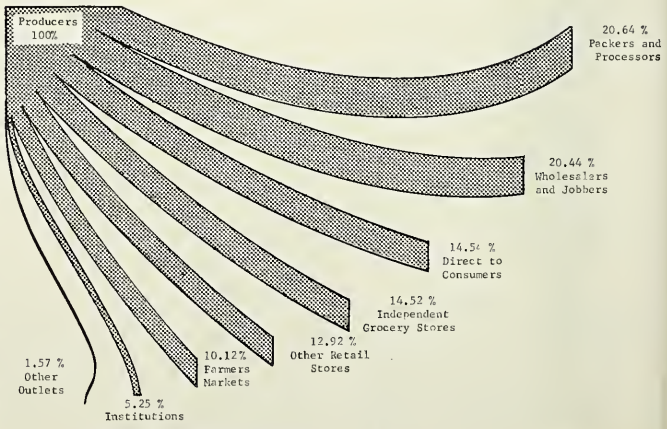


Figure 7. Disposition of eggs by W. Va. producers, 1964.